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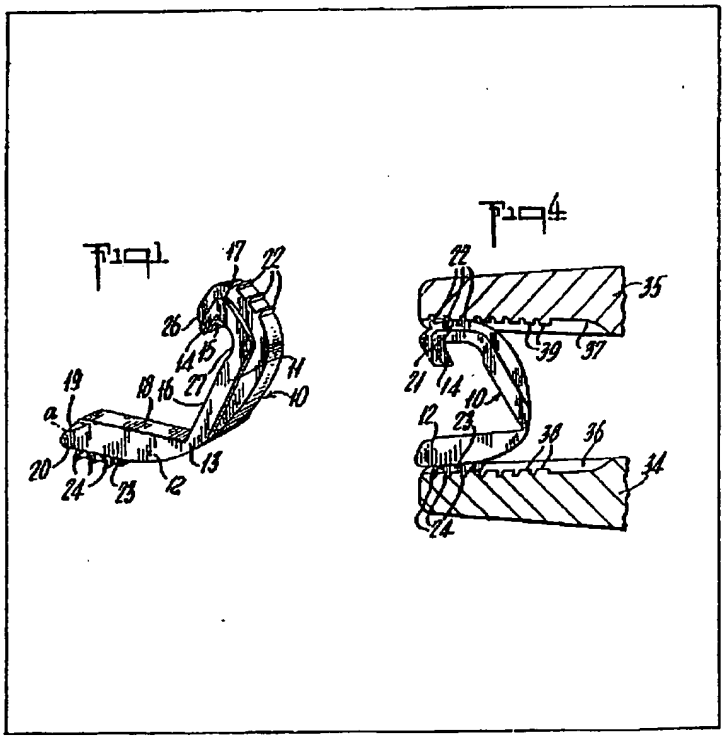
(54) **Plastic ligating clips**

(57) Plastic ligating clips of absorbable or nonabsorbable materials are formed by two legs 11, 12 joined with a resilient hinge 13. One leg terminates in a hook member 14 which secures the other leg when the clip is closed. Each leg of the clip is provided with a raised rib 21, 23 having gear-like teeth 22, 24 adapted to mesh with the corresponding teeth 38, 39 of the jaws 34, 35 in the conventional forceps-type ligating clip applier.



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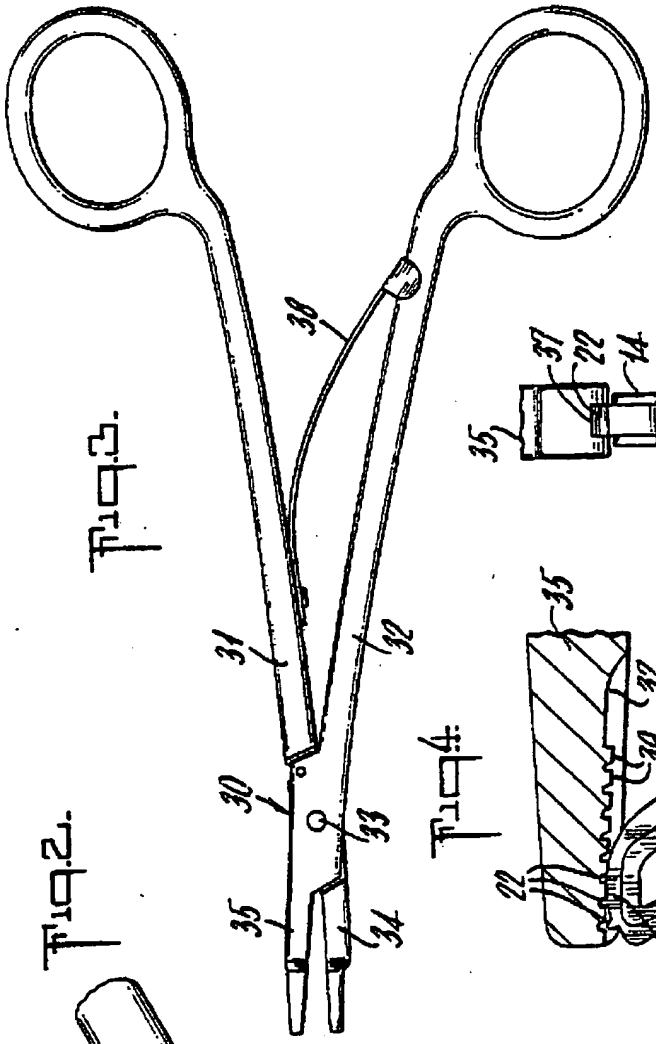

Fig.3.

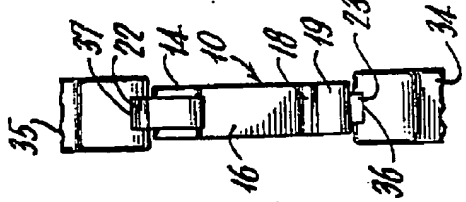

Fig.5.

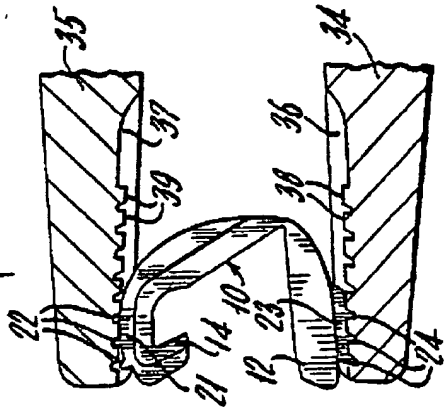

Fig.4.

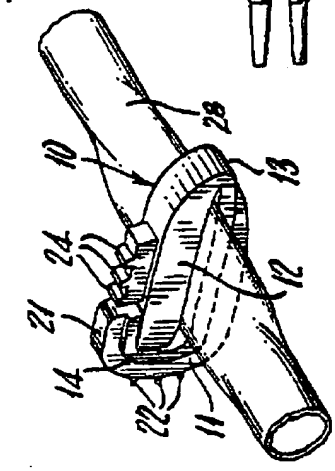

Fig.2.

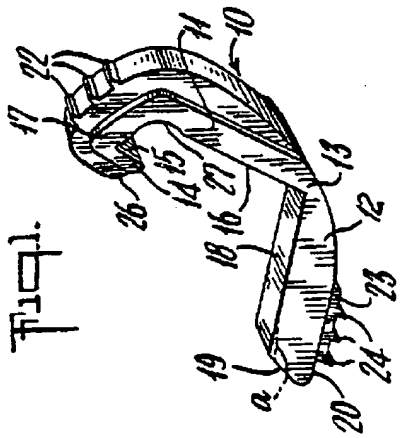

Fig.1.

SPECIFICATION

Plastic ligating clips

Background of the invention

The present invention relates to hemostatic clips and clip appliers, and, more particularly, to hemostatic clips fabricated from absorbable or nonabsorbable polymeric materials and which may be applied to blood vessels and the like with conventional instruments.

Hemostatic clips are utilized in surgical procedures to close severed blood vessels and other small fluid ducts. In the past, hemostatic clips have been narrow U-shaped or V-shaped strips formed of tantalum or stainless steel which are capable of being deformed and possess sufficient strength to retain the deformation when clamped about a blood vessel. The clips are generally applied using a forceps-type device having jaws channeled or otherwise adapted to hold the open clip. Representative hemostatic clips and appliers of the prior art are best illustrated in U.S. Patents Nos. 3,867,944; 3,631,707; 3,439,523; 3,439,522; 3,363,628; 3,312,216; and 3,270,745.

It has been suggested in the prior art, as in U.S. Patent No. 3,439,523, for example, that hemostatic clips might be formed of inexpensive plastics or materials which are slowly absorbable in the body. Unfortunately, the very small conventional U- and V-shaped hemostatic clips do not possess the required strength or deformability when constructed of known plastic materials to be successfully clamped about a blood vessel. Thus, although the need and desirability of providing inexpensive plastic ligating clips of both absorbable and nonabsorbable materials has been recognized for over ten years, there has been no practical way to satisfy this need.

U.S. 3,926,195 describes a small, plastic clip designed for the temporary or permanent close of the oviduct and vas deferens in humans. These clips preferably have a clamping surface of from 6 to 10 mm in length and 3 to 6 mm in width. The size of such clips are accordingly considerably larger than is desirable for hemostatic clips. Additionally, clips of U.S. 3,926,195 require the use of several complex tools to apply the clips which are acceptable for the purposes described in the reference but would be unacceptable in a surgical procedure requiring the rapid placement of a large number of hemostatic clips to stem the flow of blood from severed vessels.

It is accordingly an object of the present invention to provide a plastic ligating clip effective for clamping off small blood vessels and other fluid ducts in the body. It is a further object of this invention to provide plastic ligating clips of both absorbable and nonabsorbable materials. It is yet a further object of this invention to provide plastic ligating clips which are quickly and easily applied to severed blood vessels and other fluid ducts with a conventional single forceps-type instrument used in applying metallic clips.

Summary

The ligating clips of the present invention comprise two legs joined at the proximal ends thereof along a line forming a resilient hinge, with the first leg terminating in a deflectable hook member adapted to engage the distal end of the other leg. The first leg is provided with an outside raised rib having a radial curvature over substantially the entire length thereof which permits the leg to rotate forward within the jaw of the applier as the clip is closed. The outer surface of the raised rib is provided with gear-like teeth at the distal end thereof which mesh with corresponding teeth in the jaws of a conventional ligating clip applying instrument.

The second leg is provided with a short raised rib over the central portion thereof and spaced from the distal and proximal ends of the leg. This rib is also provided with gear-like teeth to mesh with corresponding teeth in the jaw of the applier.

The applier for the clips of the present invention is a conventional, forceps-type instrument wherein each jaw is channeled and gear-like teeth are provided in the base of the channel to grip the clip. The width of the raised ribs of the clip correspond to the width of the channels in the applier, and the size and spacing of the teeth on the ribs of the clip correspond to the size and spacing of the teeth in the channel of the applier.

The clips may be formed of plastic by injection molding or other suitable technique, and may be composed of a nonabsorbable material such as polypropylene or an absorbable material such as a homopolymer or copolymer of lactide and glycolide. The clips are formed in a normally open position and constructed with a small amount of material to minimize tissue reaction. The clips are readily applied to the ends of severed vessels using conventional surgical techniques.

Description of drawings

FIGURE 1 is a greatly enlarged view in perspective of a surgical clip according to the present invention.

FIGURE 2 illustrates the clip of FIGURE 1 clamped about a blood vessel.

FIGURE 3 illustrates a forceps-type applier useful with the clips of the present invention.

FIGURE 4 illustrates the clip of FIGURE 1 retained in the jaws of a forceps-type clip applier.

FIGURE 5 is an end view of FIGURE 4 illustrating the position of the clip in the jaws of the applier.

Description of preferred embodiments

Referring now to FIGURE 1, there is illustrated hemostatic clip 10 constructed of two leg segments 11 and 12 connected at the proximal ends thereof by hinge section 13. Leg 11 terminates at the distal end thereof in hook member 14. Inner face 15 of hook member 14 is substantially parallel to inner face 16 of leg 11 and forms an acute angle with extension 17 of the hook member. Leg member 12 terminates at the

distal end in surface 19 which forms a corresponding acute angle with outer surface 20. Extension 17 further forms an obtuse angle with the plane of inner face 16 of leg 11, while surface 19 of leg 12 forms a corresponding obtuse angle with the plane of inner surface 18.

The length and width of faces 16 and 18 are substantially equal, and face 15 of hook 14 is spaced from face 16 of leg 11 by a distance corresponding to the thickness of leg 12 between the plane of face 18 and surface 20. When legs 11 and 12 are pivoted about hinge 13 to bring faces 18 and 16 into opposition, hook 14 is deflected by surface 19 of leg 12 until the distal end of leg 12 snaps under hook 14 and is thereby locked in place. Front surface 26 of hook 14 is preferably rounded and angled as illustrated to facilitate the passage of leg 12 during clip closure.

When the clip is closed over a tubular vessel as illustrated in FIGURE 2, surfaces 16 and 18 engage and compress vessel 28 to close the lumen thereof. Surfaces 16 and 18 may be smooth as illustrated in FIGURE 1, or may be provided with ridges or grooves to increase vessel holding power. The distal end of surface 18 of leg 12 is preferably beveled as illustrated by broken line *a* in FIGURE 1 to reduce the thickness at the tip of the leg, thereby compensating for inward deflection of hook 14 during closure which reduces the clearance between surfaces 15 and 16 and may otherwise interfere with the latching of the clip. Closure is further facilitated by undercutting leg 11 at the juncture of extension 17 and surface 16 as illustrated at 27 in FIGURE 1 to increase the deflectability of hook member 14 and the effective space between the hook member 14 and leg 11.

Referring again to FIGURE 1, leg 11 of clip 10 includes a raised rib 21 extending from the tip of hook member 14 to a point adjacent hinge section 13. The outer surface of rib 21 defines a radial curve extending from extension 17 into the body of leg 11, and a plurality of gear-like teeth 22 extend across the width of the rib opposite extension 17. Rib 21 reinforces leg 11, and, since the rib may have less thickness than inner face 16 of leg 11, reduces the amount of material required to fabricate the clip.

Leg 12 is likewise provided with a short, raised rib 23 spaced from the distal and proximal ends thereof which includes a plurality of gear-like teeth 24 extending across the width of the rib. Rib 23 serves to reinforce the rigidity of leg 12, and also functions as a foot upon which the clip stands when held in the applier as hereinafter described.

The significance of the clip configuration as illustrated in FIGURE 1 and described above will be appreciated in connection with the instrument used to apply and close the clip as illustrated in FIGURE 3 and FIGURE 4.

FIGURE 3 illustrates a forceps-type ligating clip applier 30 comprising two handle members 31 and 32 crossing at hinge point 33 and maintained in a normally open position by spring 38. Handle 31 extends beyond hinge 33 forming jaw member 34 while the extension of handle 32 forms jaw member 35.

FIGURE 4 illustrates the detail of the construction of jaws 34 and 35 and the interaction of the jaws with the clip of FIGURE 1. Jaws 34 and 35 are of identical design and are provided respectively with channels 36 and 37 extending rearwardly from the tips of the jaws. Each channel is provided with gear-like teeth 38 and 39 across the bottom of the channel and over an area extending rearward from the tips of the jaws. The size and spacing of channel teeth 38 and 39 correspond to the size and spacing of clip teeth 24 and 22, and when the open clip is held in the applier, the teeth of the clip mesh with those of the applier as illustrated in FIGURE 4. Since the jaws of the applier have identical structure, there is no need to orient the applier to the clip when loading or using the applier.

Clip 10 is initially loaded in applier 30 in the normally open position as illustrated in FIGURE 4. After moving the jaws of the applier and the clip into position over the vessel to be ligated, the jaws of the applier are closed and the clip is locked in position over the vessel as illustrated in FIGURE 2. As the jaws of the applier are closed, leg 11 of clip 10 rotates in channel 37 until teeth 22 disengage from the channel. Thereafter, leg 11 moves forward with the curved surface of rib 21 sliding and rotating in channel 37. Simultaneously, the clip pivots backward on rib 23 of leg 12 until the distal end of leg 12 is engaged by hook member 14. Once the clip is fully closed and locked onto the vessel as illustrated in FIGURE 2, the jaws of the applier are allowed to open and the applier is withdrawn from the site to be reloaded with another clip.

Referring now to FIGURE 5, there is illustrated an end view of FIGURE 4 showing clip 10 positioned between jaws 34 and 35 of the applier with ribs 21 and 23 of the clip engaging channels 37 and 36 of the jaws, respectively.

Many variations in the clip design other than the embodiments disclosed herein will be apparent to those skilled in the art and are contemplated within the scope of the present invention. For example, while the raised ribs of the clip are illustrated as being narrower than the clamping surfaces, the entire clip could be constructed of a uniform thickness if desired. The undercut between extension 17 and surface 16 of leg 11 is optional and may be omitted, especially if the width of leg 11 is reduced. Greater or lesser numbers of teeth may be employed on the raised ribs, or other means may be employed to lock the open clip between the jaws of the applier without departing from the scope and spirit of the invention.

The clips of the present invention may be constructed in various sizes according to their intended function. Hemostatic clips are typically less than 6 mm in length, about 1.5 mm in width, and have a vessel clamping surface about 3 mm in length. The dimensions of the clip may be reduced by about 50 percent for certain applications in

microsurgery. Larger clips for special hemostatic applications and other functions such as closure of oviducts or vas deferens may have dimensions of about double those of a typical hemostatic clip. The various sizes of clips are preferably matched with individual appliers having jaws tailored to the size of the clip for best performance.

The clips of the present invention are most conveniently molded of biologically acceptable plastic materials which may be absorbable or nonabsorbable. Preferred absorbable polymers include homopolymers and copolymers of glycolide and lactide, and poly(*p*-dioxanone). Preferred nonabsorbable polymers include nylon and polypropylene. All these materials have been demonstrated to be biologically acceptable when used as sutures or other implantable medical devices. The clips may also be cast or machined from solid polymeric materials or from metals such as aluminum, magnesium, stainless steel, tantalum, and various alloys of these, some of which may also be absorbable in biological tissue.

CLAIMS

1. A hemostatic clip comprising first and second leg members joined at their proximal ends by resilient hinge means and terminating at their distal ends in latch means, each leg member having a vessel clamping inner face in opposition to a vessel clamping inner face of the other leg member;

said first leg member terminating at the distal end thereof in a deflectable hook member extending from the inner face of said leg member, said hook member having an inner face spaced from and substantially parallel to the inner face of said leg member, said leg member including a raised outer rib defining a radius of curvature over a substantial portion of said hook member and the distal end of said leg member, said rib having a plurality of gear-like teeth extending across the width of the rib opposite the extension of said hook member from said leg member;

said second leg member terminating in a distal end adapted to deflect said hook member and enter said space between the inner face of said hook member and the inner face of said first leg member, said second leg member including a raised outer rib spaced from said distal and proximal ends of said leg member and having a plurality of gear-like teeth extending across the width thereof;

whereby when said first and second leg members are pivoted about said hinge means, the distal end of said second leg member interacts with the hook member of the first leg member to lock the clip in a closed position.

2. The hemostatic clip of Claim 1 wherein said hook member extending from said first leg member defines an obtuse angle with said leg member, and the distal end of said second leg member terminates in a surface defining a corresponding obtuse angle with the inner face thereof.

3. The hemostatic clip of Claim 1 wherein said resilient hinge means is defined by a line of minimum clip thickness at the juncture of the inner faces of said first and second leg members.

4. The hemostatic clip of Claim 1 wherein said hook member is spaced from said inner face of said first leg member by a distance equal to the thickness of the distal end of said second leg member.

5. The hemostatic clip of Claim 1 wherein said inner face of said second leg member is beveled at the distal end to decrease the thickness thereof.

6. The hemostatic clip of Claim 5 wherein said hook member is spaced from the inner face of said first leg member by a distance corresponding to the unbeveled thickness of the distal end of said second leg member.

7. The hemostatic clip of Claim 1 wherein said first leg member is undercut at the juncture of said hook member and said inner face of said leg member.

8. The hemostatic clip of Claim 1 wherein said raised ribs of said first and second leg members have a width less than that of the vessel clamping inner faces of said leg members.

9. The hemostatic clip of Claim 1 wherein the raised rib of said second leg member is spaced from the distal end of said leg member by a distance corresponding to the length of the inner surface of said hook member.

10. A hemostatic clip comprising first and second leg members joined at their proximal ends by resilient hinge means and terminating at their distal ends in latch means, each leg member having a vessel clamping inner face in opposition to a vessel clamping inner face of the other leg member;

said first leg member terminating at the distal end thereof in a deflectable hook member extending from the inner face of said leg member and defining an obtuse angle therewith, said hook member having an inner face spaced from and substantially parallel to the inner face of said leg member, said leg member including a raised outer rib defining a radius of curvature over a substantial portion of said hook member and the distal end of said leg member, said rib having a plurality of gear-like teeth extending across the width of the rib opposite the extension of said hook member from said leg member;

said second leg member terminating at the distal end thereof in a surface defining an obtuse angle with the plane of said vessel clamping inner face of said leg member, the thickness of said distal end of said leg member normal to the plane of said inner face corresponding to the spacing of the inner face of said hook member from the inner face of said first leg member, and the obtuse angle at the distal end of said second leg member corresponding to the obtuse angle defined by said hook member and the inner face of said first leg member, said second leg member including a raised outer rib spaced from said distal and proximal ends of said leg member and having a plurality of gear-like teeth extending across the width thereof;

whereby, when said first and second leg members are pivoted about said resilient hinge means, the distal end of said second leg member deflects said hook member and enters between the inner face of said hook member and the inner face of said first leg member and is retained therein to maintain said clip in a closed configuration with the vessel clamping inner faces of said first and second leg members in opposition.

11. The hemostatic clip of Claim 10 wherein said resilient hinge means is defined by a line of minimum clip thickness at the juncture of the inner faces of said first and second leg members.

12. The hemostatic clip of Claim 10 wherein said inner face of said second leg member is beveled at the distal end to decrease the thickness thereof.

13. The hemostatic clip of Claim 12 wherein said hook member is spaced from the inner face of said first leg member by a distance corresponding to the unbeveled thickness of the distal end of said second leg member.

14. The hemostatic clip of Claim 10 wherein said first leg member is undercut at the juncture of said hook member and said inner face of said leg member.

15. The hemostatic clip of Claim 10 wherein said raised ribs of said first and second leg members have a width less than that of the vessel clamping inner faces of said leg members.

16. The hemostatic clip of Claim 10 wherein the raised rib of said second leg member is spaced from the distal end of said leg member by a distance corresponding to the length of the inner surface of said hook member.

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